# The Fermilab Short Sample Testing Facility

## *System Description and Integration*

- ◊ Why a Short Sample Facility ?
- ◊ What should a Short Sample Facility provide ?
- ◊ Features of the specified SSF
- ◊ Integration / Installation issues
- ◊ Schedule & Plan summary

## *Why a Short Sample Facility ?*

Success of a High Field Magnet program relies in large part on development of conductor with high $J_c$ and low winding/cabling degradation.

Conductors with high $J_c$ at high field are typically made form $NB_3Sn$ alloys - alloys whose mechanical and electrical properties are strongly affected by the heat treatment process used to produce the SC alloy.

Because the performance of SC strand made from these alloys is dependent upon the nature of the heat treatment, results from short sample tests performed at other facilities may not correlate well with observed conductor performance in magnet and coil prototypes produced with different heat treatment profiles.

Therefore, it is desirable that short sample tests can be performed in such a manner that the heat treatment of the strand/sample be identical to that used for reacting a wound coil. This is most efficiently achieved if the short sample testing facilities and high field magnet design, test, and production activities are integrated.

A further argument in favor of developing such a facility at Fermilab is that this facility will be dedicated solely to the Fermilab HFM program, and will not be shared with other research programs/customers - therefore test turn-around is enhanced, and the program will enjoy the flexibility to pursue, for example, advanced development in High Temperature superconductors - providing a solid technical foundation in this field that would be instrumental in contributing to the success of a Hi-$T_c$ magnet program.

## *What should a Short Sample Facility provide ?*

- ◊ Background magnetic field : 0 - 17T
- ◊ Good field homogeneity
- ◊ Sample temperature range : 1.8-20+ K
- ◊ Large sample volume
- ◊ Stable sample mounting
- ◊ Sample current supply : 0 - few kA ?
- ◊ Cryogenic control system
- ◊ Low operating costs
- ◊ Temperature / pressure sensors
- ◊ Sample testing instrumentation
- ◊ Automated control / monitoring
- ◊ Ease of use
- ◊ Robust design
- ◊ Flexibility
- ◊ Moderate initial cost

## *Features of the Specified SSTF*

Fermilab has ordered a system from Oxford Instruments - the

*Teslatron$^{17}$*

Teslatron$^{17}$ features :

Superconducting Magnet System

- Field strength : 17T @ 2.2K, 15T @ 4.2K
- Maximum current (@ 17T) : 118 A
- Field homogeneity : .1% over 1cm DSV
- Ramp Rate (min.) : 1T / min ( ~ 10 A / min )
- Power supply : 120A / 10V, bipolar, 0.1mA resolution
- Persistent switch w / power supply
- Diode / Resistor magnet protection
- Clear bore : 64mm dia.

Cryostat / Dewar System :

- LHe volume : 42L
- LHe consumption : 495 cm$^3$ / hr (@ 4.2K, $I_s$=0, persistent mode)
- Vapor cooled shield
- LHe level detector & readout
- Temperature sensor

Automatic LPF operation / control
Dimensions / features : (see drawings)

VTI / Sample Holders

Temperature range : 1.5K - 200K
Temp. stability : ±0.1K
Automated needle valve control
Temperature sensor
LHe level detector & readout
Sample holders for 600A & 2000A
SC sample carriers to be designed by FNAL

Control Systems :

LabVIEW based
All VI drivers provided
Automated control / readout of :
- Magnet bath temperature
- VTI temperature
- Magnetic field strength / current
- Persistent switch operation
- LHe levels
- Temperatures

Can be integrated w/ SS experiment

*Integration/Installation Issues or... now what do we do about it ??*

*Where will it go ??* Engineering Lab

Existing vacuum system, existing cryogenic operations, support instrumentation, floor space

*What else do we need to do ??*

Cryogenic/vacuum system :

- Insulating vacuum/inner vacuum chamber

  Turbomolecular pump backed w/ roughing pump,
  40 L/s turbopump speed, 5m$^3$/sec for rougher.

  These pumps presently exist and are used for the SLC - we can connect to them for occasional pumping w/ temporary plumbing, as long as concurrent operation of SLC & SSF is not attempted. Addition of LN2 cold trap recommended.

- Lambda-point Fridge

Rotary pump w/ ~ 45 $m^3$/hr pumping speed/capacity - needs to be dedicated to system while operational.

Need to locate or purchase - Balzers UNO-035D or similar (perhaps manifold from Root's Blower ??).

- VTI

Low volume, moderate vacuum pump .

Use existing Root's blower .

Tasks :

- generate parts list (valves, pumps, accessories)
- document detailed plumbing modifications
- procure parts
- perform mod's

<u>Software & Computing :</u>

Already have LabVIEW license on PC used for SLC - can (theoretically) load OI instrument drivers and control software upon delivery. This PC to be used initially, until SSF requirements/activities better determined.

Tasks :

- write SW spec for SS test procedure
- generate LabVIEW code to
    - control sample power supply
    - read temperature and pressure sensors
    - read sample voltage
    - record data
- integrate SS test code w/ OI control code for automated SS tests
    - vary temperature
    - vary background field

perform SS V/I measurements

- enlist LabVIEW programming assistance !

Instrumentation / Hardware :

The instrumentation for actual short sample tests must be supplied by Fermilab. This includes sample power supplies, voltmeters, scanners, etc. The initial plan is to utilize existing instrumentation where possible.

- Power supplies

Need power supplies to provide up to 600A sample current, controllable from PC, and with low noise, high stability

Surplus SSC supplies exist - 6 Lakeshore Model 612 125A supplies, and 2 Lakeshore Model 601 PS controllers. At least two of these can be operated in parallel (master/salve) for 250A capability. Danfysik current transducers and associated electronics also available for sample current read-out.

- DVM

Need very low voltage sensitivity and good noise rejection, typical voltages are ~ μV, sensitivities required ~ 10nV.

Use a surplus HP-3458A DVM (10nV sens @ 100mV FS, 60dB NMR). Use a second HP-3458A w/ scanner for thermometry, etc. Eventually purchase Keithley Model 182 Nano-Voltmeter (1nV sens @ 3mV FS, 90dB NMR) for sample voltage measurements.

Tasks :

- move SSC power supplies into Eng. Lab

- get documentation on SSC power supplies from manuf.
- "procure" HP-3458A's, scanner
- determine cabling, wiring requirements

Mechanical / Infrastructure :

- Sample Holders

Need to design sample holder for constraining SC wire samples. Needs to be mechanically robust, easy to remove, easy to manufacture.

Design work underway, drawings from Oxford showing sample holder area received, used for reference. Initial efforts geared towards sample holders for 600A insert for NbTi. E. Barzi to discuss details.

- Crane Height

Crane height in Engineering Lab is insufficient to allow installation of magnet insert or VTI's into dewar. Required hook height =119" - existing height = 104".

A supplementary block and tackle will be mounted on a track suspended from the crane's upper crossbar - this will allow sufficient hook height and x-y positioning over a limited area. Weight of VTI is low enough so that a 6:1 tackle can easily meet the requirements.

Installation of magnet into dewar (which should only occur infrequently) can be performed in the ICB high bay area; the dewar w/ magnet can be then rolled into the EL and put in place with the existing 1-ton crane.

- Reaction Oven

High temperature (> 700° C) oven needed to react $NB_3Sn$ wire samples when mounted onto sample holder.

Need to determine oven requirements and obtain information from vendors. Should coordinate requirements with initial model magnet coil winding plans, so that a single oven might be suitable for both purposes - unless this delays schedule.

Tasks :

- continue sample holder design / generate fab. drawings
- fabricate sample holder(s)
- generate crane modification drawings & submit for review
- procure block & tackle parts and install onto crane support
- determine oven requirements and specifications
- generate PR / RFP for reaction oven

## *Schedule & Plan Summary*

Feb. 1998...

Vacuum system modifications / installation / procurement
Sample power supply installation

Sample holder design and fabrication
Crane modifications
System delivery, unpacking, set-up

March 1998...

Power supply testing / integration
Delivered system commissioning (cryo, magnet)
SS test instrumentation integration
Software development

April 1998...

System integration
Software development
Instrumentation evaluation
Full system commissioning
SC sample preparation (NbTi)
First SS tests on SSC conductor

May 1998...

Oven delivery (?)
Ready for initial short sample testing...